CLAIMS

1. A metal oxide dispersion comprising metal oxide particles with a necking structure in a solvent, wherein the liquid droplet contact angle of the metal oxide dispersion to an ITO film (Indium-Tin Oxide type film) is from 0 to 60°.

2. The metal oxide dispersion according to claim 1, wherein the ITO film is formed on a polyethylene terephthalate surface or polyethylene naphthalate surface.

3. The metal oxide dispersion according to claim 1 or 2, wherein the solvent comprises water and an alcohol.

4. The metal oxide dispersion according to claim 3, wherein the solvent comprises water and ethanol, and the ethanol content is 40 mass% or more.

5. The metal oxide dispersion according to claim 3, wherein the solvent comprises water and 1-butanol or an isomer thereof, and the content of 1-butanol or an isomer thereof is 50 mass% or more.

6. The metal oxide dispersion according to any one of claims 1 to 5, wherein the metal oxide particles comprise a metal oxide powder having an average primary particle diameter of 100 nm to 1 μm as converted from the BET specific surface area (hereinafter referred to as Particle Group A), and a metal oxide powder having an average primary particle diameter of 5 to 40 nm as converted from the BET specific surface area (hereinafter referred to as Particle Group B).

7. The metal oxide dispersion according to claim 6, wherein the content of Particle Group A comprised in the metal oxide particle mixture is from 10 to 40 mass%.

8. The metal oxide dispersion according to claim 6 or 7, wherein Particle Group B is a mixture of a metal oxide powder having an average primary particle diameter of 20 to 40 nm as converted from the BET specific surface area (hereinafter referred to as Particle Group C), and a metal oxide powder having an average primary particle

diameter of 5 to 20 nm as converted from the BET specific surface area (hereinafter referred to as Particle Group D).

9. A metal oxide dispersion for the production of a dye-sensitized solar cell electrode, comprising Metal Oxide Particle Group F having a necking structure formed by m connected particles, Metal Oxide Particle Group G having only 0.2m or less connected particles, and a solvent, and being formable into a film at 200°C or less.

10. The metal oxide dispersion according to claim 9, which further comprises a binder.

11. The metal oxide dispersion according to claim 9 or 10, wherein the particle size distribution of Particle Group F has a distribution constant of 1.5 or more as determined according to the Rosin-Rammler formula.

12. The metal oxide dispersion according to any one of claims 9 to 11, wherein Particle Group F is titanium dioxide.

13. The metal oxide dispersion according to any one of claims 9 to 12, wherein the average particle diameter of Particle Group F is from 250 nm to 3 μm as measured by using a laser diffraction-type particle size distribution meter.

14. The metal oxide dispersion according to any one of claims 9 to 13, wherein Particle Group F comprises titanium dioxide synthesized by the vapor phase process of oxidizing titanium tetrachloride with an oxidative gas at a high temperature.

15. The metal oxide dispersion according to any one of claims 9 to 14, wherein Particle Group F comprises ultrafine particulate titanium dioxide which is obtained by reacting a titanium tetrachloride-comprising gas and an oxidative gas after preheating respective gases at 500°C or more, and which has an average primary particle diameter of 7 to 500 nm as converted from the BET specific surface area.

16. The metal oxide dispersion according to any one of claims 9 to 15, wherein Particle Group F comprises titanium dioxide synthesized by supplying a titanium tetrachloride-comprising gas and an oxidative gas each preheated at 500°C or more to a reaction tube each at a flow velocity of 10 m/sec or more.

17. The metal oxide dispersion according to claim 16, wherein the titanium dioxide of Particle Group F is synthesized by causing said titanium tetrachloride-comprising gas and said oxidative gas to stay in said reaction tube for 1.0 second or less under a high-temperature condition that the temperature inside said reaction tube exceeds 600°C.

18. The metal oxide dispersion according to claim 16 or 17, wherein the titanium dioxide of Particle Group F is synthesized by setting the average flow velocity of said gases in said reaction tube to 5 m/sec or more.

19. The metal oxide dispersion according to any one of claims 9 to 18, wherein the titanium dioxide of Particle Group F is synthesized by supplying the preheated titanium tetrachloride-comprising gas and oxidative gas into the reaction tube to cause turbulence.

20. The metal oxide dispersion as claimed in any one of claims 9 to 19, wherein the average primary particle diameter of Particle Group F is from 20 to 40 nm as converted from the BET specific surface area.

21. The metal oxide dispersion according to any one of claims 9 to 20, wherein Particle Group G comprises titanium dioxide synthesized by hydrolyzing an aqueous titanium compound solution in water.

22. The metal oxide dispersion according to any one of claims 9 to 21, wherein the average primary particle diameter of Particle Group G is from 4 to 100 nm as converted from the BET specific surface area.

23. The metal oxide dispersion according to any one of claims 9 to 22, wherein the average particle diameter of Particle Group G is from 4 to 2,000 nm as measured by

a laser diffraction-type particle size distribution meter.

24. The metal oxide dispersion according to any one of claims 1 to 23, wherein the titanium dioxide is a titanium dioxide structure having an optical band gap of 2.7 to 3.1 eV as calculated from absorbance measured by an integrating sphere-type spectrophotometer, and a tap density of 0.15 to 0.45 g/cm^3.

25. The metal oxide dispersion according to any one of claims 1 to 24, wherein the metal oxide is a mixture of titanium dioxide, and at least one metal oxide selected from zinc oxide, niobium oxide, tantalum oxide, zirconium oxide, tin oxide and tungsten oxide.

26. The metal oxide dispersion according to claim 25, wherein the content of titanium dioxide comprised in the metal oxide mixture is 10 mass% or more.

27. The metal oxide dispersion according to any one of claims 1 to 26, which comprises from 0.01 to 20 parts by weight of a binder per 100 parts by weight of the metal oxide.

28. The metal oxide dispersion according to any one of claims 1 to 27, wherein the binder is a water-soluble polymer compound.

29. The metal oxide dispersion according to claim 28, wherein the water-soluble polymer compound is a polymer compound comprising, as the monomer unit, at least one member selected from N-vinylacetamide, acrylamide, vinylpyrrolidone and sodium acrylate.

30. The metal oxide dispersion according to any one of claims 1 to 29, wherein the binder is a zirconium compound.

31. The metal oxide dispersion, wherein when said metal oxide dispersion is coated on a transparent electrically conducting resin substrate to an area of 1 cm^2 and film-formed at 150°C and an N3 dye is adsorbed thereto, and when the resulting electrode film is disposed to oppose an FTO transparent electrically

conducting glass having a platinum-applied electrically conducting face, and after injecting an acetonitrile solution comprising an iodine-based electrolyte into the space therebetween, the Nyquist plotting is performed under the open voltage condition with irradiation of pseudo sunlight of 100 mW, the minimum value of the impedance imaginary number part in the circular arc including 20 Hz is from -25 to -0.01 Ω.

32. The metal oxide dispersion according to any one of claims 1 to 31, wherein the metal oxide dispersion is used for forming an electrode.

33. A method for producing an electrode for dye-sensitized solar cells, comprising a step of coating the metal oxide dispersion according to any one of claims 1 to 32 on an electrically conducting resin substrate to form a metal oxide electrode film comprising metal oxide particles bound on the electrically conducting resin substrate.

34. The method for producing an electrode for dye-sensitized solar cells according to claim 33, wherein the method further comprises treating the electrically conducting resin substrate with an ultraviolet ray irradiation treatment before coating the metal oxide dispersion.

35. The method for producing an electrode for dye-sensitized solar cells according to claim 33, wherein the method further comprises treating the electrically conducting resin substrate with an ozone treatment before coating the metal oxide dispersion.

36. The method for producing an electrode for dye-sensitized solar cells according to claim 33, wherein the method further comprises treating the electrically conducting resin substrate with a corona discharge treatment before coating the metal oxide dispersion.

37. The method for producing an electrode for dye-sensitized solar cells according to claim 33, wherein the method further comprises treating the electrically

conducting resin substrate with a surfactant before coating the metal oxide dispersion.

38. The method for producing an electrode for dye-sensitized solar cells according to claim 33, wherein the method further comprises treating the electrically conducting resin substrate with an electrolytic oxidation treatment in an electrolyte solution before coating the metal oxide dispersion.

39. The method for producing an electrode for dye-sensitized solar cells according to claim 33, wherein the method further comprises forming an undercoat layer on the electrically conducting resin substrate before coating the metal oxide dispersion.

40. The method for producing an electrode for dye-sensitized solar cells according to claim 39, wherein the thickness of the undercoat layer is from 10 to 2,000 nm.

41. A method for producing an electrode for dye-sensitized solar cells, comprising stacking metal oxide fine particles differing in the composition to enhance the light usability within the electrode.

42. A method for coating the metal oxide dispersion according to any one of claims 1 to 32 on an electrically conducting resin substrate, comprising using the method according to any one of claims 33 to 41.

43. A thin film formed by using the metal oxide dispersion according to any one of claims 1 to 32.

44. A thin film formed by using the metal oxide dispersion according to any one of claims 1 to 32 and using the method according to any one of claims 33 to 41.

45. The thin film according to claim 43 or 44, wherein the film thickness is from 1 to 40 μm.

46. A dye-sensitized solar cell comprising a dye electrode using, as a constituent element, the thin film according to any one of claims 43 to 45.

47. A dye-sensitized solar cell having an electrode surface area of S cm^2 and formed on a resin substrate, wherein when the Nyquist plotting is performed under the

open voltage condition with irradiation of pseudo sunlight of 100 mW, the minimum value of the impedance imaginary number part in the circular arc including 20 Hz is from -25S to -0.01S Ω.

48. An article comprising, on the surface or inside thereof the dye-sensitized solar cell according to Claim 46 or 47, and having at least one function selected from a power-generating function, a light-emitting function, a heat-generating function, a sound-generating function, a moving function, a displaying function and an electric charging function.

49. The article according to claim 48, which is at least one member selected from the group consisting of a building material, lighting equipment, a decorative windowpane, a machine, a vehicle, a glass product, a home appliance, an agricultural material, an electronic device, a cellular phone, a beauty tool, a handheld terminal, a PDA (Personal Digital Assistant), an industrial tool, tableware, bath goods, toilet goods, furniture, clothing, a cloth product, a fiber, a leather product, a paper product, a resin product, sporting goods, bedding, a container, a spectacle, a billboard, piping, wiring, a metal fitting, a hygiene material, automobile equipment, stationery, an emblem, a hat, a bag, a shoe, an umbrella, a window shade, a balloon, piping, wiring, a metal fitting, illumination, a LED, a signal, a street light, a toy, a road sign, an ornament, a traffic light, a bulletin board, an outdoor product such as a tent and a cooler box, an artificial flower, an objet d'art, a power source for a cardiac pacemaker, and a power source for a heater or a cooler with a Peltier element.

50. A metal oxide electrode comprising an electrically conducting substrate having thereon a metal oxide layer comprising metal oxide particles bound by a binder, wherein the binder content is from 0.005 to 5 mass% based on the metal oxide film and the metal oxide

layer has a pencil scratch strength of H or more according to JIS5600.

51. The metal oxide electrode according to claim 50, wherein the binder content is from 0.01 to 2 mass% based on the metal oxide film.

52. The metal oxide electrode according to claim 50, wherein the binder content is from 0.01 to 1 mass% based on the metal oxide film.

53. The metal oxide electrode according to any one of claims 50 to 52, wherein the metal oxide particles have necking structure.

54. The metal oxide electrode according to any one of claims 50 to 53, wherein the metal oxide particle comprises titanium dioxide obtained, in a vapor phase process of high-temperature oxidizing titanium tetrachloride with an oxidative gas to produce titanium dioxide, by preheating a titanium tetrachloride-comprising gas and an oxidative gas each at 500°C or more and supplying these gases to a reaction tube each at a flow velocity of 10 m/sec or more.

55. The metal oxide electrode according to any one of claims 50 to 53, wherein the metal oxide particle comprises a titanium dioxide structure having an optical band gap of 2.7 to 3.1 eV as calculated from absorbance measured by an integrating sphere-type spectrophotometer, and a tap density of 0.15 to 0.45 g/cm^3.

56. The metal oxide electrode according to any one of claims 50 to 55, wherein the binder is a hydrophilic binder comprising a hydroxyl group, a carboxyl group, a carbonyl group, an amido group, an amino group, an imido group, an imino group, an ester bond, an ether bond or other high-polarity moiety.

57. The metal oxide electrode according to claim 56, wherein the hydrophilic binder is any one member selected from poly-N-vinylacetamide, polyacrylamide, polyvinylpyrrolidone, a vinylpyrrolidone-acetamide copolymer, a vinylpyrrolidone-acrylamide copolymer and

polytetrafluoroethylene.

58. The metal oxide electrode film according to any one of claims 50 to 57, wherein the metal oxide layer has a film thickness of 1 to 40 μm.

59. The metal oxide electrode according to any one of claims 50 to 58, wherein the metal oxide layer comprises at least two or more metal oxide particle groups selected from a metal oxide particle group having a specific surface area of 1 m^2/g to less than 30 m^2/g as measured by the BET method, and a metal oxide particle group having a specific surface area of 30 to 500 m^2/g as measured by the BET method.

60. The metal oxide electrode according to any one of claims 50 to 59 wherein, in the metal oxide layer, 30 mass% or more of the metal oxide constituting the metal oxide layer is a metal oxide synthesized by a vapor phase process.

61. The metal oxide electrode according to any one of claims 50 to 60, wherein the metal oxide comprises 10 mass% or more of titanium dioxide.

62. The metal oxide electrode according to any one of claims 50 to 61, wherein the metal oxide layer has a pencil scratch strength of 3H to 7H according to JIS5600.

63. The metal oxide electrode according to any one of claims 50 to 62, wherein the electrically conducting substrate has flexibility.

64. A method for producing a metal oxide electrode, comprising coating a metal oxide liquid dispersion comprising a metal oxide particle, a hydrophilic binder and a solvent on an electrically conducting substrate and drying it to form a metal oxide layer comprising metal oxide particles bound by a hydrophilic binder.

65. The method for producing a metal oxide electrode according to claim 64 wherein the metal oxide liquid dispersion coated on the electrode substrate is then heated at 200°C or less to remove the solvent.

66. A dye-sensitized solar cell with a dye

electrode comprising, as a constituent element, the metal oxide electrode according to any one of claims 50 to 65.

67. An article comprising, on the surface or inside thereof the dye-sensitized solar cell according to Claim 66, and having at least one function selected from a power-generating function, a light-emitting function, a heat-generating function, a sound-generating function, a moving function, a displaying function and an electric charging function.

68. The article according to claim 67, which is at least one member selected from the group consisting of a building material, lighting equipment, a decorative windowpane, a machine, a vehicle, a glass product, a home appliance, an agricultural material, an electronic device, a cellular phone, a beauty tool, a handheld terminal, a PDA (Personal Digital Assistant), an industrial tool, tableware, bath goods, toilet goods, furniture, clothing, a cloth product, a fiber, a leather product, a paper product, a resin product, sporting goods, bedding, a container, a spectacle, a billboard, piping, wiring, a metal fitting, a hygiene material, automobile equipment, stationery, an emblem, a hat, a bag, a shoe, an umbrella, a window shade, a balloon, piping, wiring, a metal fitting, illumination, a LED, a signal, a street light, a toy, a road sign, an ornament, a traffic light, a bulletin board, an outdoor product such as a tent and a cooler box, an artificial flower, an objet d'art, a power source for a cardiac pacemaker, and a power source for a heater or a cooler with a Peltier element.